1. A chemical process system comprising:

a first unit operation adapted to be in fluid communication with an inlet stream and an outlet stream;

a pressure vessel at least partially containing the first unit operation therein, the pressure vessel concurrently adapted to be occupied by an inert medium to compress the first unit operation; and

a purge stream adapted to be in fluid communication with an inert medium source for selectively conveying the inert medium from the inert medium source and into fluid communication with the first unit operation.

2. The chemical process system of claim 1, wherein the first unit operation includes a chemical reactor.

3. The chemical process system of claim 1, further comprising a second unit operation in thermal communication with the first unit operation.

4. The chemical process system of claim 3, wherein the second unit operation includes at least one of a heat exchanger and a chemical reactor.

5. The chemical process system of claim 3, wherein at least one of the first unit operation and the second unit operation includes microchannels.

6. The chemical process system of claim 2, wherein:

the chemical reactor includes microchannels;

the inlet stream includes a first reactant stream; and

the outlet stream includes a first product stream.

7. The chemical process system of claim 1, wherein the first unit operation is at least one of cooled and heated at least in part by the inert medium.

8. The chemical process system of claim 1, wherein the inert medium includes at least one of helium, neon, argon, krypton, xenon, and nitrogen.

9. The chemical process system of claim 1, wherein the inert medium includes water.

10. The chemical process system of claim 6, wherein the microchannels include a catalyst.

11. The chemical process system of claim 10, wherein the catalyst comprises at least one of a catalytic lining, a catalytic pellet, and a catalytic insert.

12. The chemical process system of claim 1, wherein the inert medium within the pressure vessel is adapted to be in fluid communication with at least one of a heat exchanger, a pump, a compressor, and an inert medium source.

13. The chemical process system of claim 1, further comprising a controller operatively coupled to a first sensor monitoring an internal pressure within the pressure vessel and a second sensor monitoring an internal pressure within the first unit operation, wherein the controller is responsive to data generated by the first sensor and the second sensor to operate the pressure vessel at a higher pressure than the first unit operation.

14. The chemical process system of claim 13, wherein the controller is operatively coupled to a vent valve in fluid communication with the pressure vessel to selectively vent at least a portion of the inert medium within the pressure vessel to decrease the internal pressure within the pressure vessel.

15. The chemical process system of claim 13, wherein the controller is operative to detect a leak within the first unit operation from the data generated by at least one of the first sensor and the second sensor.

16. The chemical process system of claim 5, wherein the second unit operation is at least partially contained within the pressure vessel.

17. A chemical process system comprising:

a first unit operation including microchannels adapted to be in fluid communication with an inlet stream and an outlet stream;

a second unit operation in thermal communication with the first unit operation; and

a pressure vessel at least partially containing the first unit operation therein and adapted to be concurrently occupied by a compressive medium adapted to maintain the first unit operation in compression.

18. The chemical process system of claim 17, wherein the second unit operation includes at least one of a heat exchanger and a chemical reactor.

19. The chemical process system of claim 18, wherein the second unit operation includes a chemical reactor adapted to be in fluid communication with a reactant stream and a product stream.

20. The chemical process system of claim 19, wherein the second unit operation also includes a heat exchanger facilitating thermal energy transfer between the second unit operation and the first unit operation.

21. The chemical process system of claim 18, wherein the second unit operation includes a heat exchanger facilitating thermal energy transfer between the second unit operation and the first unit operation.

22. The chemical process system of claim 17, further comprising a purge stream adapted to be in fluid communication with the compressive medium and in selective fluid communication with the first unit operation.

23. The chemical process system of claim 17, wherein:

the first unit operation includes at least one of a chemical reactor, a heat exchanger, a mixer, and a separation unit; and

the second unit operation includes at least one of a chemical reactor, a heat exchanger, a mixer, and a separation unit.

24. The chemical process system of claim 23, wherein the pressure vessel at least partially contains the second unit operation.

25. The chemical process system of claim 24, wherein:

the second unit operation includes microchannels; and

the first unit operation and the second unit operation are coupled together in a single microchannel module.

26. The chemical process system of claim 25, wherein:

the first unit operation includes a chemical reactor;

the first unit operation includes a catalyst in series with the microchannels thereof; and

the catalyst comprises at least one of a catalytic lining, a catalytic pellet, and a catalytic insert.

27. The chemical process system of claim 26, wherein:

the second unit operation includes a chemical reactor;

the second unit operation includes a catalyst in series with the microchannels thereof; and

the catalyst comprises at least one of a catalytic lining, a catalytic pellet, and a catalytic insert.

28. The chemical process system of claim 25, wherein the pressure vessel at least partially contains a plurality of microchannel modules therein.

29. The chemical process system of claim 25, wherein:

at least one of the microchannels of the first unit operation and the microchannels of the second unit operation include a catalyst in series therewith; and

the microchannels at least one of upstream of the catalyst and downstream from the catalyst comprise a heat exchanger.

30. The chemical process system of claim 29, wherein:

the microchannels of the first unit operation and the second unit operation each include a catalyst in series therewith; and

the microchannels of the first unit operation and the second unit operation at least one of upstream of the catalyst and downstream from the catalyst each include a heat exchanger.

31. The chemical process system of claim 30, wherein the microchannels of the first unit operation are adapted to carry a first fluid in a first direction and the microchannels of the second unit operation are adapted to carry a second fluid in a second direction, opposite the first direction.

32. The chemical process system of claim 25, further comprising a controller to regulate an internal pressure within the pressure vessel.

33. The chemical process system of claim 17, wherein the pressure vessel includes a recycle stream for cycling the compressive medium into and out of the pressure vessel.

34. A method of starting up one or more unit operations, the method comprising the steps of:

feeding a material to a first unit operation including microchannels therein;

processing, within the first unit operation, at least a portion of the material;

monitoring at least one of internal pressure, temperature, and concentration at least one of within the first unit operation or downstream from the first unit operation; and

pressurizing a containment device, at least partially containing the first unit operation therein, with a compressive medium to maintain a pressure differential between an internal pressure within the containment device and an internal pressure within the first unit operation such that the internal pressure within the containment device is greater than the internal pressure within the first unit operation.

35. The method of claim 34, further comprising the step of adjusting the internal pressure within the containment device to track the internal pressure within the first unit operation.

36. The method of claim 34, wherein the first unit operation includes a tubular flow reactor.

37. The method of claim 34, wherein the pressurizing step includes the step of monitoring the internal pressure within the containment device.

38. The method of claim 34, wherein the pressurizing step includes providing selective fluid communication between the containment device and a compressive medium source.

39. The method of claim 34, wherein the compressive medium includes at least one of an inert medium, the material fed to the first unit operation, and the processed material exiting the first unit operation.

40. The method of claim 34, further comprising the steps of:

feeding a composition to a second unit operation;

processing, within the second unit operation, at least a portion of the composition;

monitoring at least one of internal pressure, temperature, and concentration at least one of within the second unit operation or downstream from the second unit operation; and

pressurizing the containment device, at least partially containing the second unit operation therein, with the compressive medium to maintain the pressure differential between the internal pressure within the containment device and an internal pressure within the second unit operation such that the internal pressure within the containment device is greater than the internal pressure within the second unit operation.

41. The method of claim 40, wherein the second unit operation includes microchannels through which the composition may flow therethrough.

42. A method of shutting down one or more unit operations, the method comprising the steps of:

containing at least a portion of a first unit operation including microchannels within a pressure containment vessel including an inert medium operative to compress the first unit operation;

decreasing material within a supply stream entering the first unit operation;

directing inert medium into fluid communication with the first unit operation to provide an inert concentration within the first unit operation;

monitoring at least one of pressure, temperature, and concentration at least one of within and downstream from the first unit operation; and

increasing the inert medium concentration within the first unit operation.

43. The method of claim 42, wherein the containing step includes the step of venting the inert medium to a lower pressure sink to reduce an internal pressure of the pressure containment vessel.

44. The method of claim 42, wherein the directing step includes directing at least a portion of the inert medium from the pressure containment vessel into fluid communication with the first unit operation to provide the inert concentration within the first unit operation.

45. The method of claim 42, further comprising the steps of:

containing at least a portion of a second unit operation within the pressure containment vessel including the inert medium operative to compress the second unit operation;

decreasing a feed supply within a feed supply stream entering the second unit operation; and

monitoring at least one of pressure, temperature, and concentration at least one of within and downstream from the second unit operation.

46. The method of claim 45, further comprising the steps of:

directing inert medium into fluid communication with the second unit operation to provide an inert concentration within the second unit operation; and

increasing the inert concentration within the second unit operation.

47. The method of claim 46, wherein the second unit operation includes microchannels.

48. A unit operation containment system comprising:

a first unit operation including microchannels adapted to be coupled to a supply stream and an outlet stream;

a pressure containment device adapted to maintain at least a portion of the first unit operation in compression via a pressurized medium, where the pressure containment device is in selective fluid communication with a medium source; and

a controller operatively coupled to at least a first system sensor detecting an internal pressure within the first unit operation and a second system sensor detecting an internal pressure within the pressure containment device, the controller being responsive to data generated by the first system sensor and the second system sensor to adjust the internal pressure within the pressure containment device.

49. The unit operation containment system of claim 48, wherein the first unit operation includes a plurality of microchannels in which at least a portion of a chemical reaction takes place.

50. The unit operation containment system of claim 48, further comprising a second unit operation in thermal communication with the first unit operation.

51. The unit operation containment system of claim 50, wherein:

the second unit operation includes microchannels therein; and

the microchannels of the second unit operation are coupled to the microchannels of the first unit operation to provide an integrated module.

52. The unit operation containment system of claim 48, wherein:

the pressure containment device includes an integrated module at least partially housed therein;

the first unit operation includes a chemical reactor;

the second unit operation includes at least one of a chemical reactor and a heat exchanger;

the chemical reactor of the first unit operation is housed within the pressure containment device; and

at least one of a chemical reactor and a heat exchanger of the second unit operation are housed within the pressure containment device.

53. The unit operation containment system of claim 48, wherein

the controller is operatively coupled to a control valve in fluid communication with the medium source and upstream from the pressure containment device to selectively provide the pressurized medium to the containment device and increase the internal pressure therein in response to data received from the first sensor and the second sensor; and

the pressure containment device includes an outlet stream including a vent valve in series therewith to vent excess pressurized medium from the pressure containment device.

54. The unit operation containment system of claim 48, wherein the pressure containment device includes a purge valve in series therewith, operatively coupled to the controller, and in selective fluid communication with the first unit operation.

55. The unit operation containment system of claim 48, wherein the second unit operation includes a chemical reactor in thermal communication with the chemical reactor of the first unit operation.

56. The unit operation containment system of claim 55, wherein the first unit operation includes a heat exchanger comprising microchannels at least one of upstream and downstream from the chemical reactor of the first unit operation, and the second unit operation includes a heat exchanger comprising microchannels at least one of upstream and downstream from the chemical reactor of the second unit operation in thermal communication with the heat exchanger of the first unit operation.

57. The unit operation containment system of claim 48, wherein:

the pressure containment vessel includes a recycle stream; and

the recycle stream is in series with at least one of a compressor, a pump, a condenser, and a heat exchanger.

58. The unit operation containment system of claim 48, wherein the pressurized vessel includes at least one refurbishment line to refurbish a catalyst in series with a chemical reactor of the first unit operation.

59. The unit operation containment system of claim 48, wherein:

the pressurized medium includes an inert medium; and

the inert medium within the pressure containment device is in selective fluid communication with a chemical reactor of the first unit operation.

60. A process unit comprising:

a first microchannel module comprising:

a first unit operation including microchannels, in which at least a portion of a unit operation takes place, adapted to be in fluid communication with a first inlet stream and a first outlet stream,

a second unit operation including microchannels adapted to be in thermal communication with the first unit operation, the second unit operation adapted to be in fluid communication with a second inlet stream and a second outlet stream; and

a pressurized vessel at least partially containing the first microchannel module adapted to be concurrently occupied by a compressive medium in thermal communication with the first microchannel module.

61. The process unit of claim 60, wherein:

at least one microchannel of the first unit operation is adjacent to at least one microchannel of the second unit operation and in thermal communication therewith;

at least one of a chemical reactor, a mixer, a chemical separation unit, and a heat exchanger includes the at least one microchannel of the first unit operation; and

at least one of a chemical reactor, a mixer, a chemical separation unit, and a heat exchanger includes the at least one microchannel of the second unit operation.

62. The process unit of claim 61, wherein:

the first unit operation includes a chemical reactor including the at least one microchannel;

the at least one microchannel of the first unit operation includes a catalyst in series therewith; and

the catalyst comprises at least one of a catalytic lining, a catalytic pellet, and a catalytic insert.

63. The process unit of claim 62, wherein:

the chemical reactor of the first unit operation houses the catalyst therein;

the at least one microchannel of the first unit operation is adjacent to the at least one microchannel of the second unit operation; and

the at least one microchannel of the first unit operation is adapted to carry a first fluid therein in a first direction and the at least one microchannel of the second unit operation is adapted to carry a second fluid in a second direction.

64. The process unit of claim 63, wherein:

the pressurized vessel is generally cylindrical in shape; and

the first microchannel module is generally rectangular in cross-section.

65. The process unit of claim 60, wherein at least one of the first unit operation and the second operation is in fluid communication with an open atmosphere.

66. The process unit of claim 60, wherein:

the first unit operation includes a first chemical reactor adapted to receive a first reactant feed via the first inlet stream;

the second unit operation includes a second chemical reactor adapted to receive a second reactant feed via the second inlet stream;

the first chemical reactor and the second chemical reactor are adapted to be maintained in compression by the compressive medium within the pressurized vessel; and

the first microchannel module comprises a plurality of laminated sheets.

67. A process unit comprising:

a first chemical reactor including microchannels adapted to be in fluid communication with a first reactant stream and a first product stream;

a second chemical reactor including microchannels adapted to be in thermal communication with the first chemical reactor, wherein the microchannels of the second chemical reactor are adapted to be in fluid communication with a second reactant stream and a second product stream; and

a pressurized vessel containing the first chemical reactor and the second chemical reactor, wherein the pressurized vessel is adapted to be concurrently occupied by a compressive medium in thermal communication with the first chemical reactor.

68. The process unit of claim 67, wherein the compressive medium includes water and the pressurized vessel is an elevated temperature water source.

69. The process unit of claim 67, wherein the compressive medium includes an inert medium.

70. The process unit of claim 67, wherein the first chemical reactor accommodates a throughput of between 100 liters per hour to approximately 10,000 liters per hour.

71. The process unit of claim 67, further comprising a vent valve in fluid communication with the pressurized vessel.

72. The process unit of claim 67, further comprising a controller operatively coupled to sensors associated with the pressurized vessel and the first chemical reactor, wherein the controller is operative to maintain an internal pressure within the pressurized chamber to be greater than an internal pressure within the first chemical reactor.

73. The process unit of claim 67, further comprising a purge stream providing selective fluid communication between an interior of the pressurized vessel and an interior of the first chemical reactor.

74. The process unit of claim 67, further comprising a recycle stream for cycling the inert medium into and out of the pressurized vessel, wherein a heat exchanger is in thermal communication with the recycle stream.

75. The process unit of claim 67, further comprising:

a first heat exchanger comprising microchannels in fluid communication with the microchannels of the first chemical reactor;

a second heat exchanger comprising microchannels in fluid communication with the microchannels of the second chemical reactor;

at least a portion of the microchannels of the first heat exchanger are housed within the pressurized vessel; and

at least a portion of the microchannels of the second heat exchanger are housed within the pressurized vessel.

76. The process unit of claim 75, wherein:

at least one of the microchannels of the first heat exchanger is adjacent to at least one of the microchannels of the second heat exchanger;

the at least one microchannel of the first heat exchanger is adapted to carry a first fluid therein in a first direction; and

the at least one microchannel of the second heat exchanger is adapted to carry a second fluid therein in a second direction.

77. The process unit of claim 76, wherein the first fluid has a higher thermal energy content than the second fluid.

78. The process unit of claim 76, wherein:

the first fluid includes a product from an exothermic reaction; and

the second fluid includes a reactant for an endothermic reaction.

79. The process unit of claim 76, wherein:

the first fluid includes a product from an exothermic reaction; and

the second fluid includes a reactant for an exothermic reaction.

80. A process unit comprising:

a chemical process conduit including microchannels adapted to be in fluid communication with a chemical process stream; and

a pressurized vessel containing at least a portion of the chemical process conduit;

wherein the pressurized vessel is adapted to be concurrently occupied by a compressed medium and at least the portion of the chemical process conduit;

wherein at least a portion of the chemical process conduit is maintained in compression by the compressed medium within the pressurized vessel.

81. The process unit of claim 80, further comprising a process conduit in thermal communication with the chemical process conduit and in fluid communication with a process conduit stream.

82. The process unit of claim 81, wherein:

a first reaction occurs within the microchannels of the chemical process conduit; and

the chemical process stream is adapted to be in fluid communication with a reactant supply stream and a product stream.

83. The process unit of claim 82, wherein:

the process conduit includes microchannels;

a second reaction occurs within the microchannels of the process conduit; and

the process conduit stream is adapted to be in fluid communication with a second reactant supply stream and a second product stream;

84. The process unit of claim 83, further comprising a heat exchange recuperator adapted to exchange thermal energy with at least one of the reactant supply stream, the product stream, the second reactant supply stream, and the second product stream.

85. The process unit of claim 84, wherein the heat exchange recuperator includes microchannels.

86. The process unit of claim 85, wherein the heat exchange recuperator is at least partially contained within the pressurized vessel.

87. The process unit of claim 86, wherein:

the microchannels of the chemical process stream are wholly contained within the pressurized vessel;

the microchannels of the process conduit are wholly contained within the pressurized vessel; and

the microchannels of the heat exchange recuperator are wholly contained within the pressurized vessel.

88. The process unit of claim 80, wherein the compressed medium contained within the pressurized vessel includes an inert medium.

89. The process unit of claim 83, wherein the compressed medium contained within the pressurized vessel includes a reactant from at least one of the reactant supply stream and the second reactant supply stream.

90. The process unit of claim 83, wherein the compressed medium contained within the pressurized vessel includes a product from at least one of the product stream and the second product stream.

91. A method of operating a unit operation comprising the steps of:

containing a first microchannel module at least partially within a containment vessel, the first microchannel module comprising a first unit operation and a second unit operation, where the first unit operation and the second unit operation each include at least one of a chemical reactor, a mixer, a chemical separation unit, and a heat exchanger;

pressurizing the containment vessel at least partially housing the first unit operation and the second unit operation with a compressive medium within the containment vessel;

operating the first unit operation and the second unit operation to include passing a first fluid through the first unit operation and a second fluid through the second unit operation; and

monitoring at least one of an internal pressure within the first unit operation, an internal pressure within the second unit operation, and an internal pressure within the containment vessel;

wherein the first unit operation and the second unit operation include microchannels conveying the first fluid through the first unit operation and conveying the second fluid through the second unit operation.

92. The method of claim 91, wherein the first microchannel module includes a plurality of laminated sheets mounted to one another to define internal microchannels of the first unit operation and the second unit operation, where at least one of the internal microchannels of the first unit operation is adjacent to at least one of the internal microchannels of the second unit operation.

93. The method of claim 92, further comprising the step of adjusting the pressure within the containment vessel to maintain a predetermined pressure differential between the internal pressure of the containment vessel and at least one of the internal pressure of the first unit operation and the internal pressure of the second unit operation.

94. The method of claim 93, further comprising the steps of:

carrying out a fluid medium reaction within the first unit operation; and

carrying out a fluid medium reaction within the second unit operation;

wherein thermal energy is exchanged between the first fluid and the second fluid based in part upon the nature of the fluid medium reactions carried out in the first unit operation and the second unit operation.

95. The method of claim 91, wherein:

the first unit operation includes a chemical reactor;

the second unit operation includes a chemical reactor; and

the compressive medium contained within the containment vessel includes at least one of a reactant from at least one of a reactant supply stream in fluid communication with the first unit

operation and a reactant from at least one of a reactant supply stream in fluid communication with the second unit operation.

96. The process unit of claim 91, wherein the compressive medium contained within the containment vessel includes at least one of a product from at least one of a product stream in fluid communication with the first unit operation and a product from at least one of a product stream in fluid communication with the second unit operation.